TABLE IV. Smooth-curve values of the effective adiabatic elastic constants c_{11}, c_{44}, and C', in units of 10^{11} dyn cm^{-2}, as a function of pressure at various temperatures. Calculated values of $1/\beta^S$ are also given at two temperatures.

$T=315$°K					
p(kbar)	c_{11}	p(kbar)	c_{11}	p(kbar)	c_{11}
0	3.396	4	3.757	8	4.063
2	3.583	6	3.914	10	4.205

$T=295$°K				
p(kbar)	c_{11}	c_{44}	C'	$1/\beta^S$
0	3.419	0.792	1.318	1.662
2	3.615	0.805	1.343	1.824
4	3.789	0.879	1.363	1.972
6	3.949	0.951	1.3815	2.107
8	4.097	1.020	1.398	2.233
10	4.236	1.091	1.4145	2.350

$T=275$°K					
p(kbar)	c_{11}	c_{44}	p(kbar)	c_{11}	c_{44}
0	3.430	0.754	6	3.978	0.975
2	3.639	0.830	8	4.129	1.046
4	3.819	0.903	10	4.272	1.114

$T=255$°K				
p(kbar)	c_{11}	c_{44}	C'	$1/\beta^S$
0	3.411	0.778	1.330	1.638
2	3.654	0.856	1.358	1.843
4	3.843	0.931	1.379	2.004
6	4.010	1.003	1.397	2.147
8	4.162	1.073	1.4135	2.277
10	4.302	1.140	1.4285	2.397

compressible than a single crystal. Indeed, the same kind of discrepancy between single crystal and Bridgman's polycrystalline value is also observed in ammonium chloride.[12]

Constant-Volume Data

In the temperature region above the lambda point, it is possible to combine the results presented above to obtain the variation of the elastic constants with temperature at constant volume. From the known temperature dependence of the cubic cell parameter at 1 atm and the pressure dependence of $s(p)$, one can compute the hydrostatic pressure which must be applied to the crystal at any given temperature in order to maintain its volume at a constant value. This has been done for the 17 different values of the volume: V_1 corresponds to a unit cell dimension of $a_1=3.985$ Å; V_2 through V_{12} correspond to a values which are each 0.005 Å greater than the previous value (up to $a_{12}=4.040$ Å); V_{13} through V_{17} correspond to $a_{13}=4.0425$, $a_{14}=4.045$, $a_{15}=4.0476$, $a_{16}=4.0496$, and $a_{17}=4.0517$ Å. The corresponding p–T isochores are plotted in Fig. 2. With these isochores, one can easily evaluate the effective adiabatic elastic constants at constant volume. Such constants have been plotted in Figs. 3–5 for a few high-volume values as a comparison with the variation at constant pressure. Constant-volume elastic constants are shown in Fig. 9 as a function of temperature for all 17 values of V.

DISCUSSION

Far from the Lambda Transition

As shown in Fig. 2, the principal region of this investigation is the disordered β phase of ammonium bromide. At pressures up to about 3000 bar the elastic constants show a nonlinear variation with pressure due to the fact that the crystal is still in the vicinity of the β–γ lambda line. At higher pressures, farther from the lambda line, the variation is linear as expected for a normal solid having no transition. This is clearly illustrated by the temperature variation of the constant-volume elastic constants shown in Fig. 9. Presented in Table V is a comparison of our data on ammonium bromide with recent data on ammonium chloride[12]; these results are discussed below in the general context of the behavior which is known for alkali halide crystals. The NH_4Cl elastic constants have been measured in a region of the phase diagram which contains the lambda line[12]; therefore the behavior of these constants will be somewhat influenced by the proximity of the order–disorder transition. On the other hand, NH_4Br should be typical of a "normal" CsCl-type crystal (at least above 3000 bar).

Haussuhl[22] has found that all alkali halides of the NaCl type obey the inequality $T'<T_{11}<T_{44}$, where T_{ij} represents $(\partial \ln c_{ij}/\partial T)_p$ at atmospheric pressure and is a negative quantity. For several alkali halides of the CsCl type the inequality has been found[20] to be

$$T_{44}<T_{11}<T'. \tag{8}$$

As shown in Table V, the slopes at 320°K of the elastic constants of ammonium bromide obey this CsCl in-

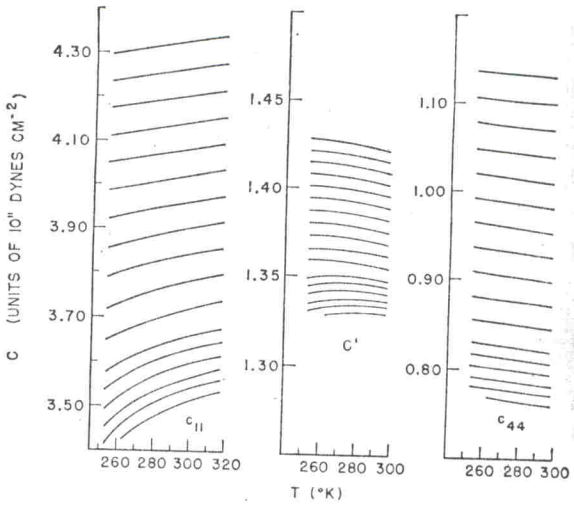

FIG. 9. Adiabatic elastic constants versus temperature at various constant volumes from V_1 to V_{17} (see text). The highest curves correspond to V_1.

[22] S. Haussuhl, Z. Physik **159**, 223 (1960).